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Identification and Significance of Innovation

Structured heterogeneity with nanomaterials tailoring advances makes it possible to create thermoelectrics using high temperature polymer composites. While such materials lack the capability to approach top performing ceramic module efficiency (BiTe), they provide two unique aspects in energy scavenging: large area coverage and kinetic energy/heat scavenging integration. Wake Forest University demonstrated a novel design for internal p/n junction formation in such composites that allows a significant increase in thermoelectric voltage and power while retaining fabric form. This advancement in nanocomposite thermoelectric performance coupled with active kinetic energy scavenging makes the piezo-thermo-electric PowerFelt™ applicable to many power collection scenarios. This program demonstrates that PowerFelt™ can rival small ceramic modules in overall power generation in a flexible, lightweight platform. PowerFelt™ has advanced printing technique compatibility, at ~\$0.5/



Estimated TRL at beginning and end of contract: (Begin: 2 End: 4)

Technical Objectives and Work Plan

The primary goal of this project is to demonstrate the scientific, technical, and commercial merit and feasibility of an innovative, conformable fabric covering that can scavenge power from highly energetic environments. The compact, robust and lightweight platform will have specific manufacturing advantages over ceramic thermo-electrics and piezo-electrics and allow for large area coverings. This will be achieved through the use of rapid print prototyping that will show a direct path to commercial production of large area, power-generating fabrics. The specific technical objectives are demonstrating printing as an approach to the manufacture of appliques and plaques by producing test pieces with an internal interconnect system that allows for ease of use and single-unit applications on 5 cm x 10 cm printed fabrics using our cross - thread interconnects. Our target performance will be 50 mW @ $T \sim 10^{\circ}\text{C}$ and 1Hz vibration with a 1-+m stroke to confirm the combined thermal and kinetic energy scavenging capabilities. The test articles will be robust to puncture, scuffing, most solvents or scratching, and will provide power regardless of the direction of heat flow or the form of mechanical energy. Next, a 1-m² fabric will be manufactured embedded with printed multimodule pieces that will have a specific area density of approximately 50 grams/m². Subsequent testing will verify that the overall power output will scale with area.

NASA Applications

The harvesting of power from heat has wide applications including supplemental/backup power for instrument and life support on manned space vehicles and ISS; main/supplemental power source for unmanned space vehicles, exploration vehicles, and sounding rockets; power for experimental equipment; stabilizing and decreasing the temperature of sensitive components to increase the sensitivity of detectors, CCD, thermal imaging cameras, solid state lasers and other sensors.

Non-NASA Applications

Generating electricity from heat has DOD applications with fatigues; MOPP suits; tents; backpacks; vehicles; unmanned vehicles; aircraft; helicopters; naval ships; thermal stability for detectors, CCD, IR cameras, lasers and sensors. Civilian applications are similar with clothing; cell phone holsters; tents; backpacks; vehicles, including passenger compartment; and emergency power generation.

Firm Contacts

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